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Min et al.

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(54) **ROD REDUCING DEVICE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 403 days.

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(22) Filed: **Oct. 17, 2019**

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Related U.S. Application Data

(63) Continuation of application No. 15/873,370, filed on Jan. 17, 2018, now Pat. No. 10,485,590.

(60) Provisional application No. 62/447,519, filed on Jan. 18, 2017.

(51) **Int. Cl.**
A61B 17/88 (2006.01)
A61B 17/70 (2006.01)

(52) **U.S. Cl.**
CPC ***A61B 17/7086*** (2013.01); ***A61B 17/7002*** (2013.01); ***A61B 17/7091*** (2013.01); *A61B 17/7032* (2013.01); *A61B 17/7041* (2013.01); *A61B 17/7085* (2013.01)

(58) **Field of Classification Search**
CPC A61B 17/7086; A61B 17/7002; A61B 17/7091; A61B 17/7032; A61B 17/7041; A61B 17/7085
USPC ..... 606/265, 279, 99, 86 A
See application file for complete search history.

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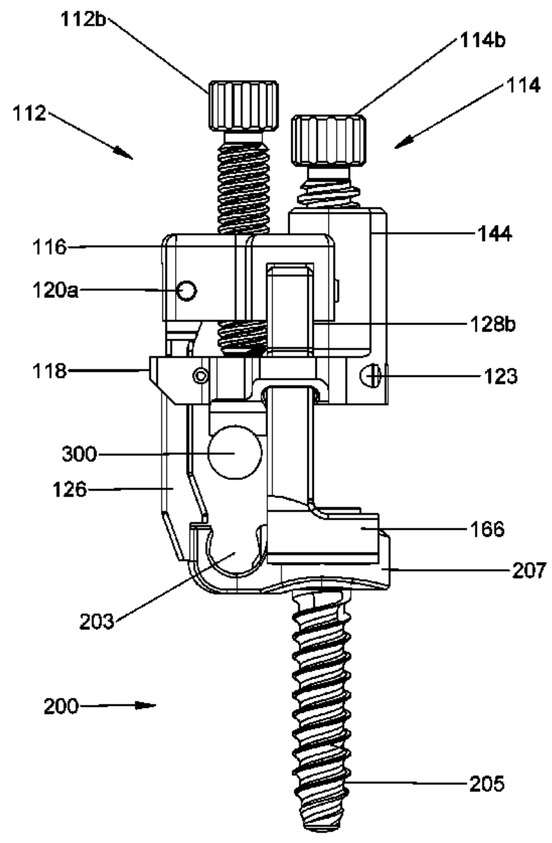
(57) **ABSTRACT**

A rod reducer includes a housing, an anvil, a locking anvil configured to engage a locking plug of a bone screw assembly, an arm assembly, a reducing screw extending through the housing and rotatably coupled with the anvil, and a locking screw extending through the housing and rotatably coupled with the locking anvil. The arm assembly includes an arm hingedly coupled to the housing, and first and second grasping members configured to engage the bone screw assembly. The first and second grasping members are hingedly coupled to the housing and extend through the anvil. Rotation of the reducing screw transitions the arm assembly between an open position, in which, distal portions of the arm and the first and second grasping members are radially expanded, and a closed position, in which, the distal portions of the arm and the first and second grasping members are radially contracted.

18 Claims, 13 Drawing Sheets



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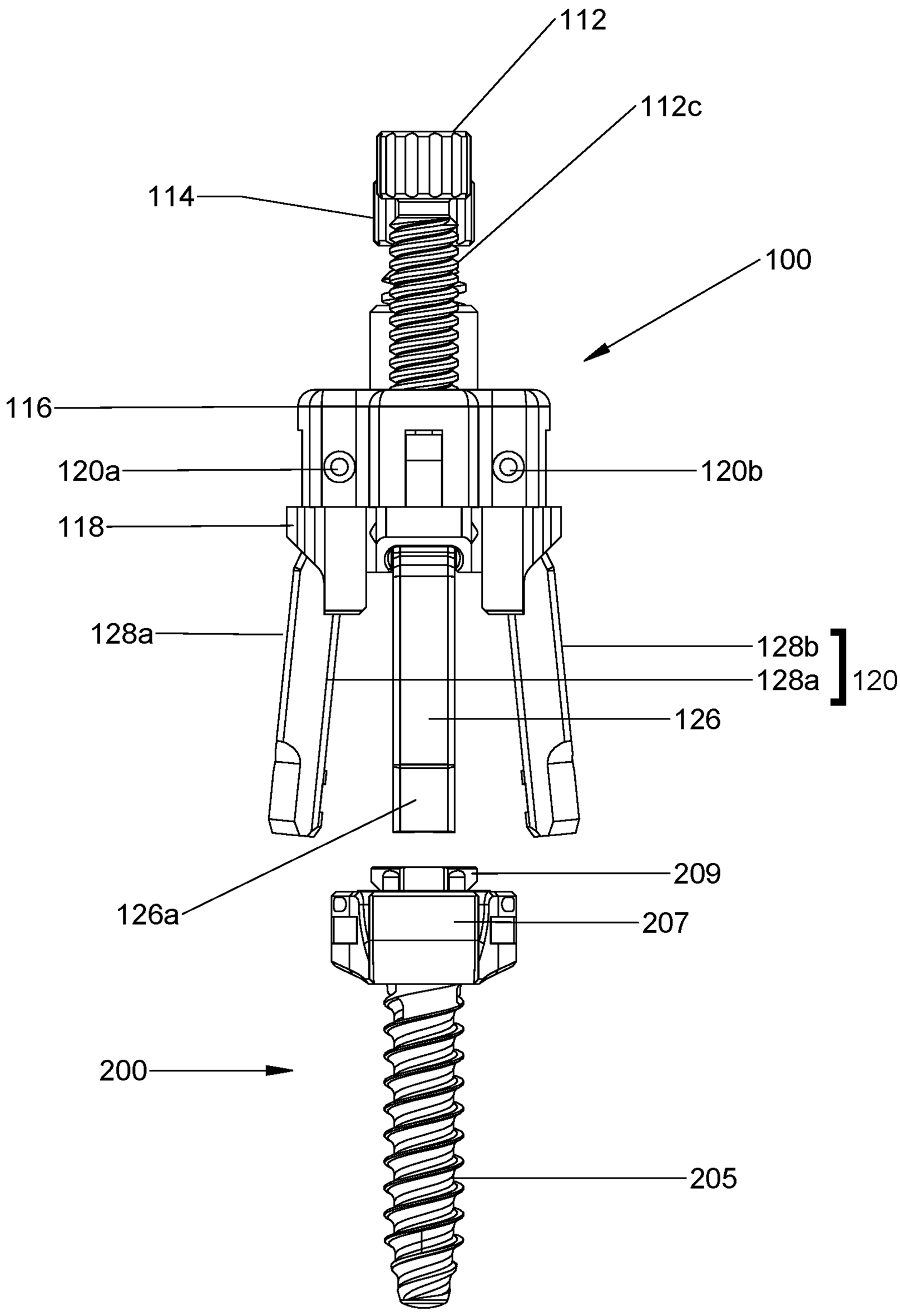
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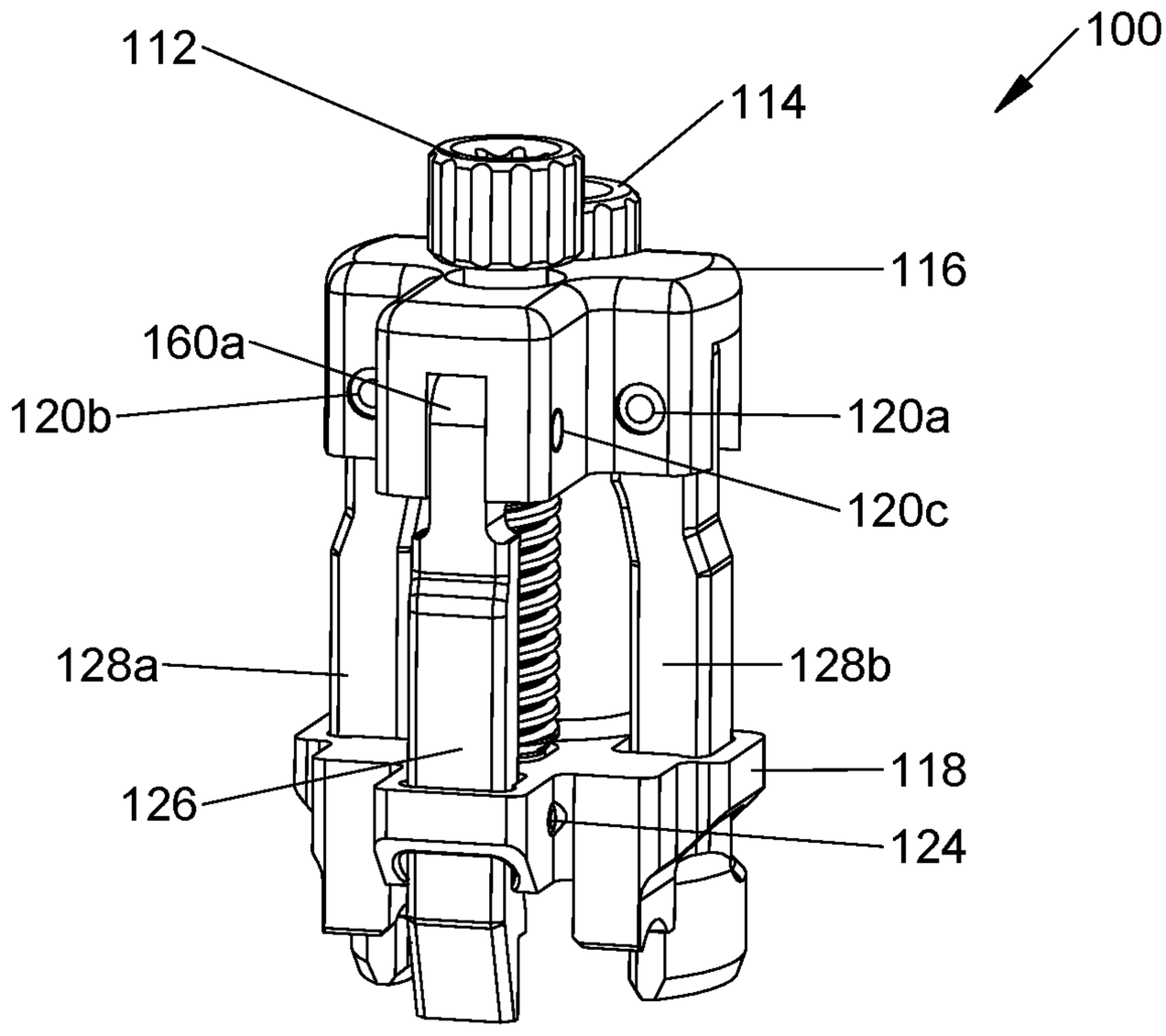
FIG. 1



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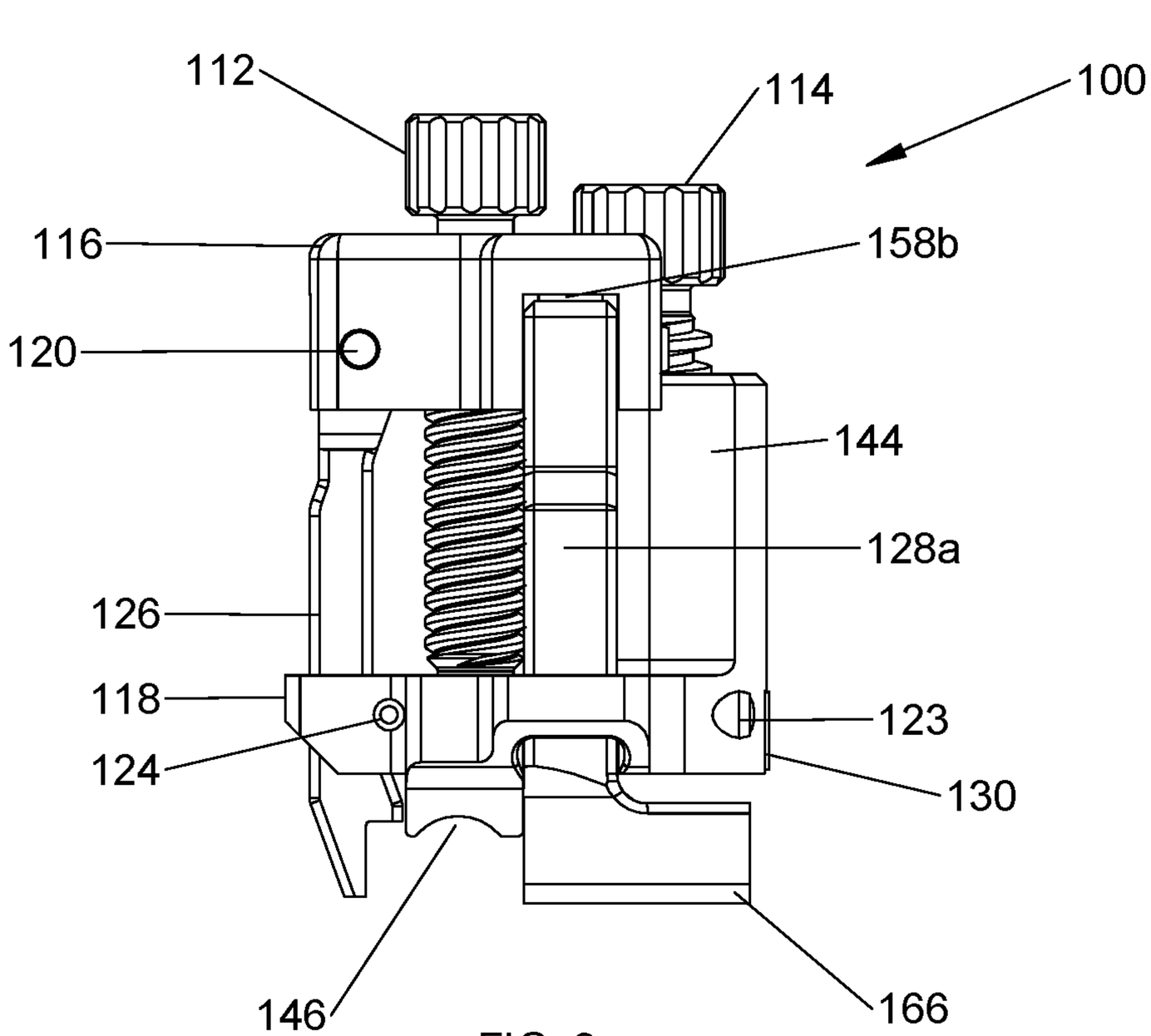

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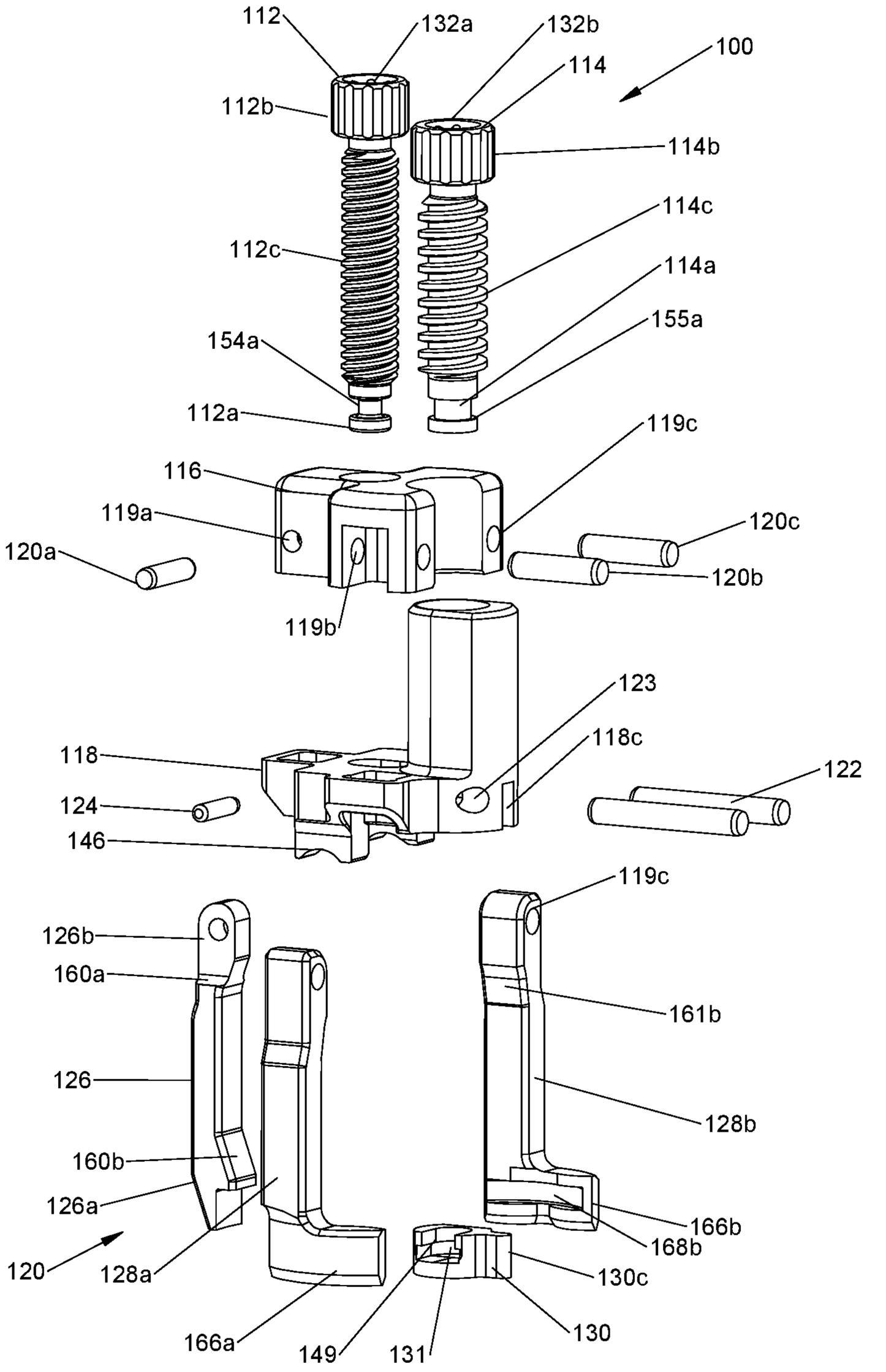
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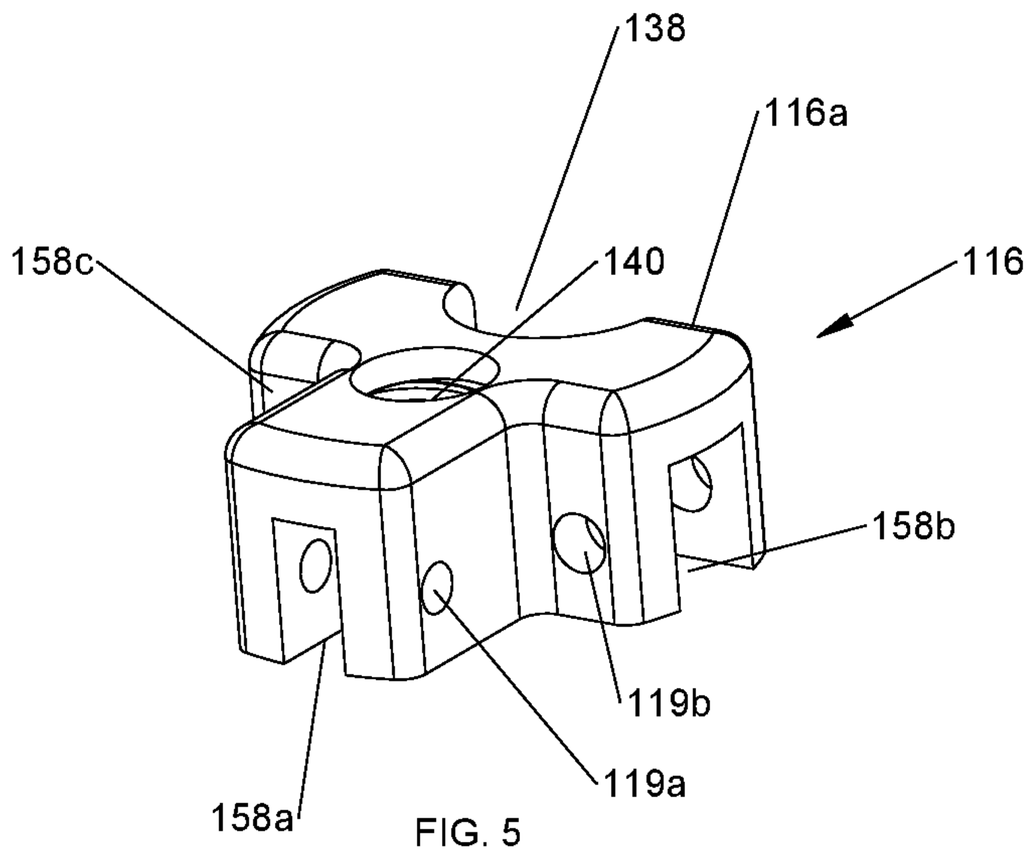
FIG. 4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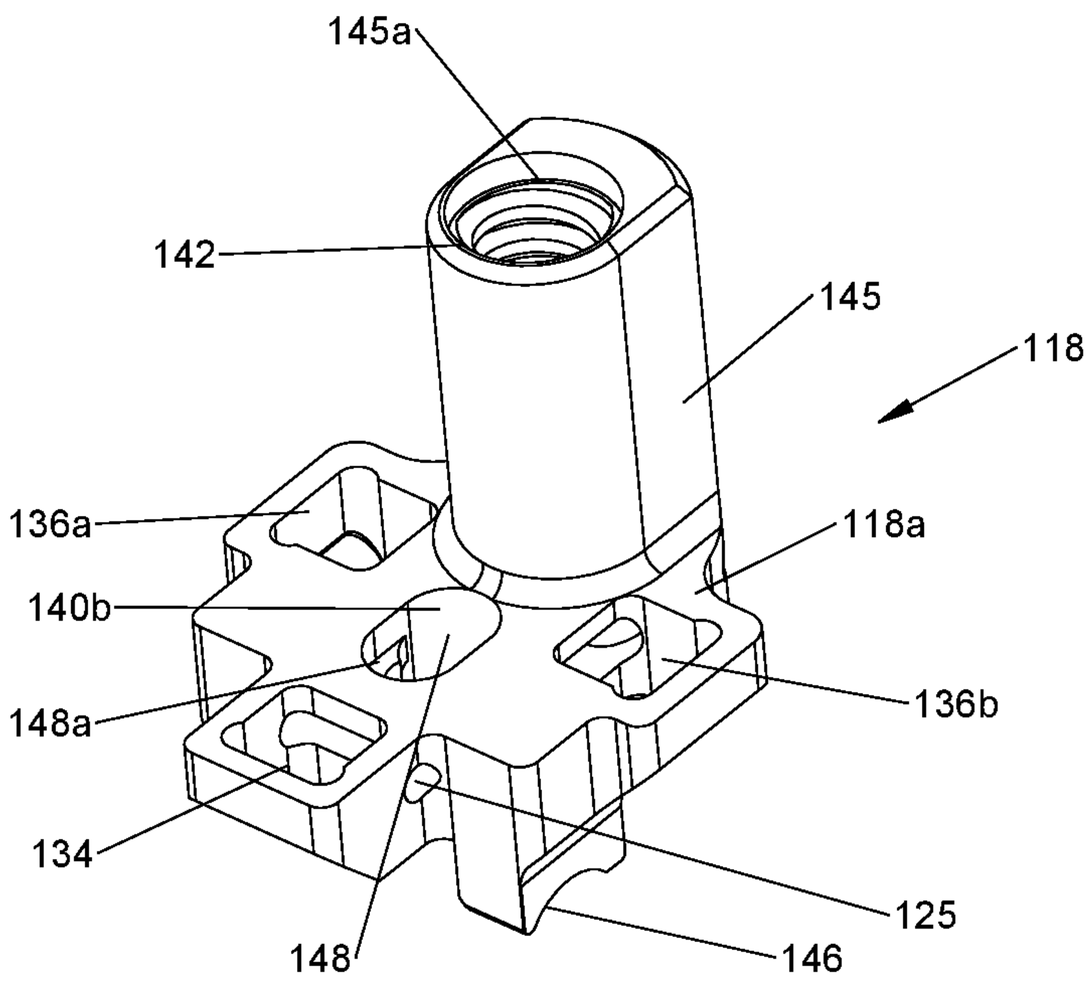
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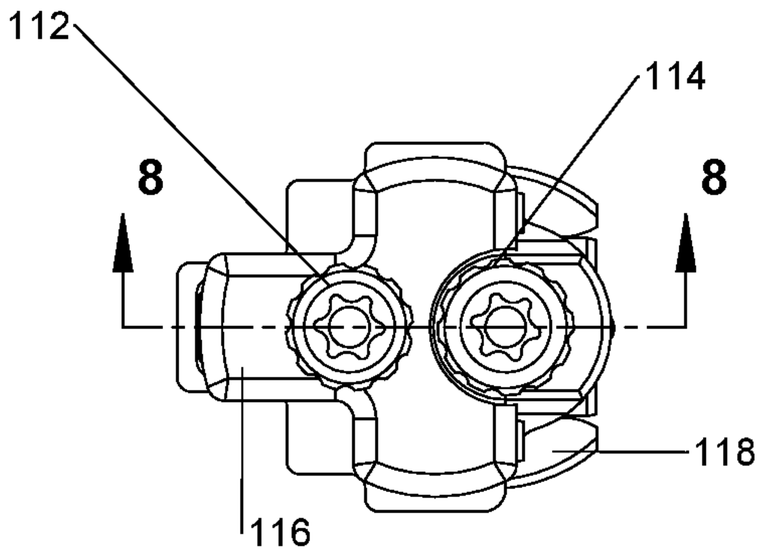
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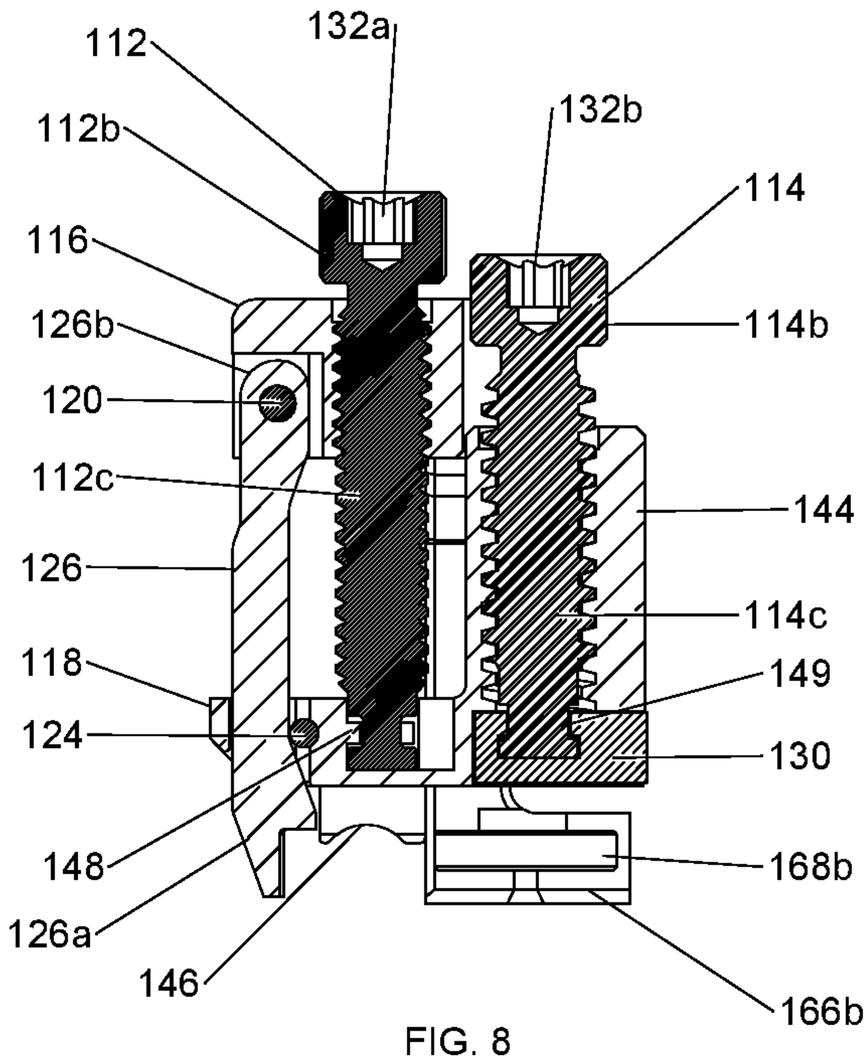
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FIG. 8

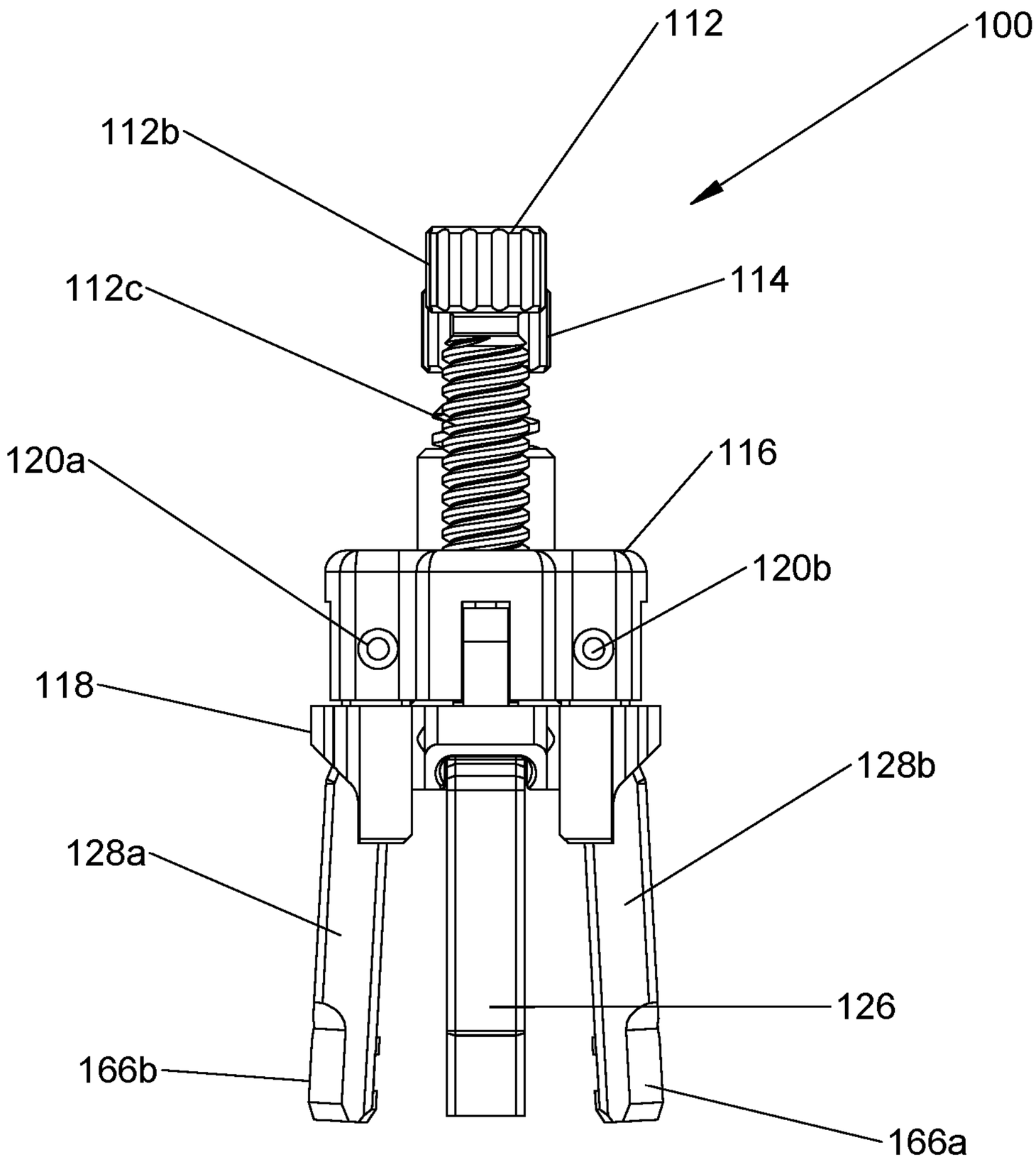
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FIG. 9

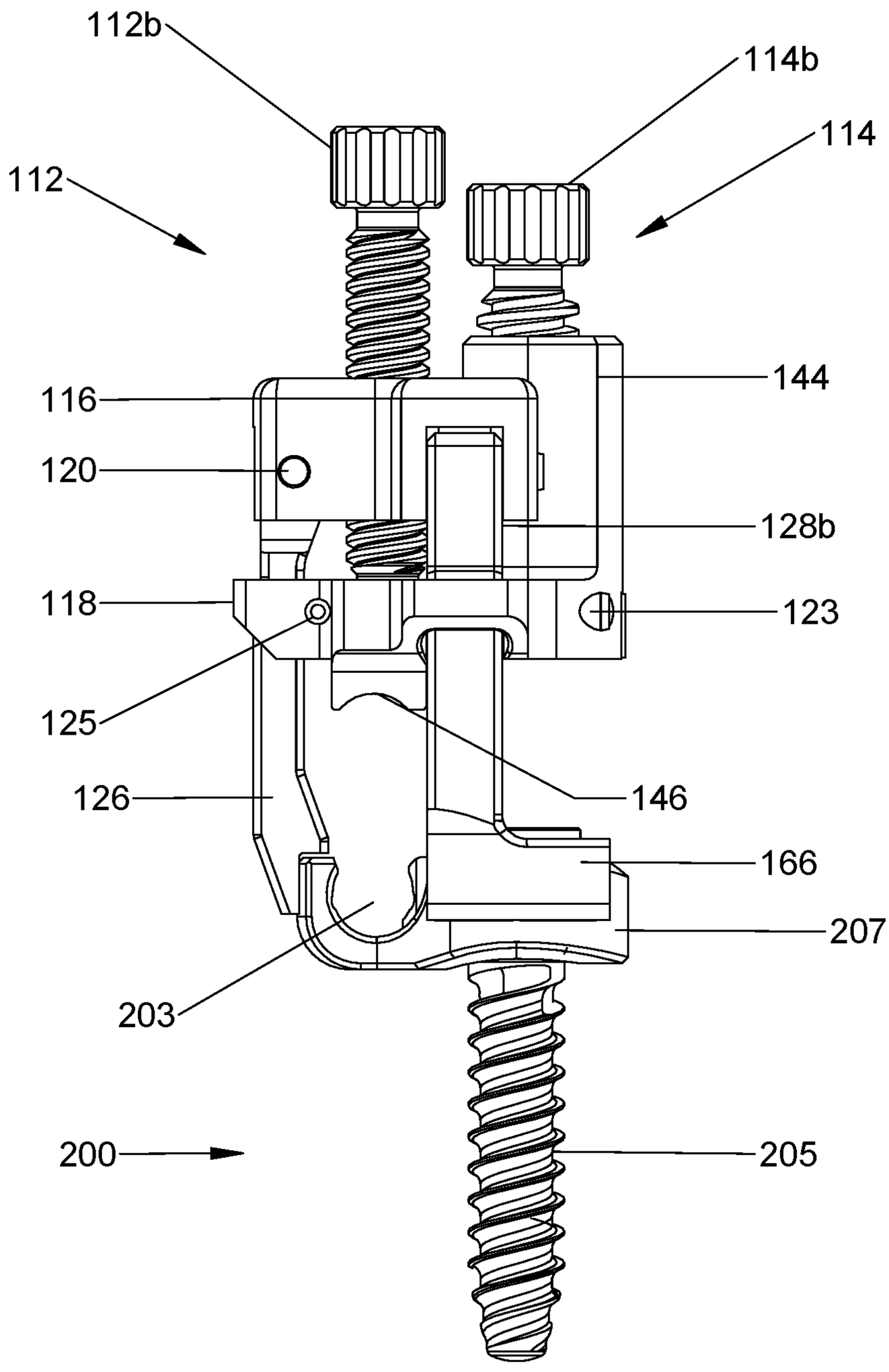
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FIG. 10

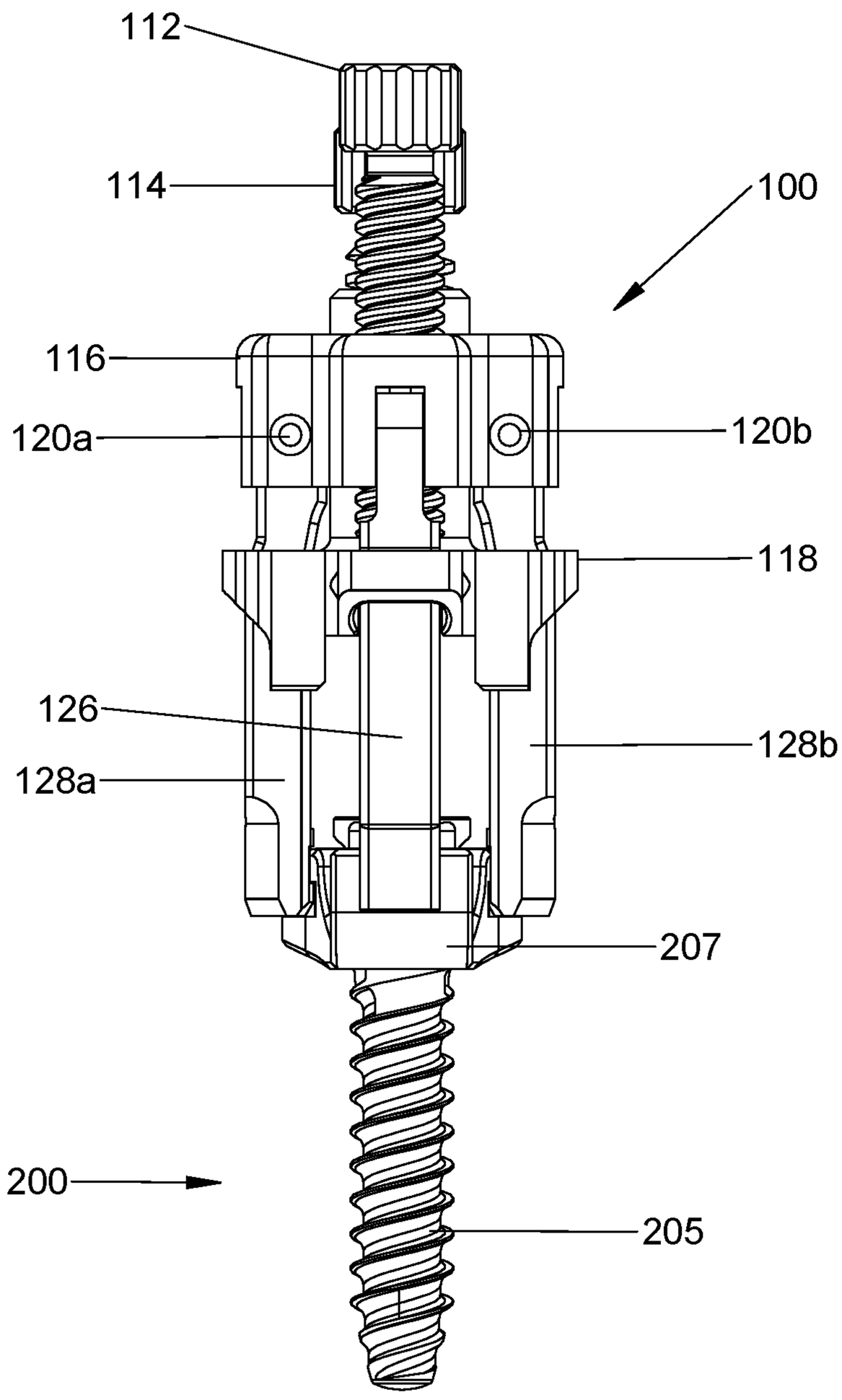

FIG. 11

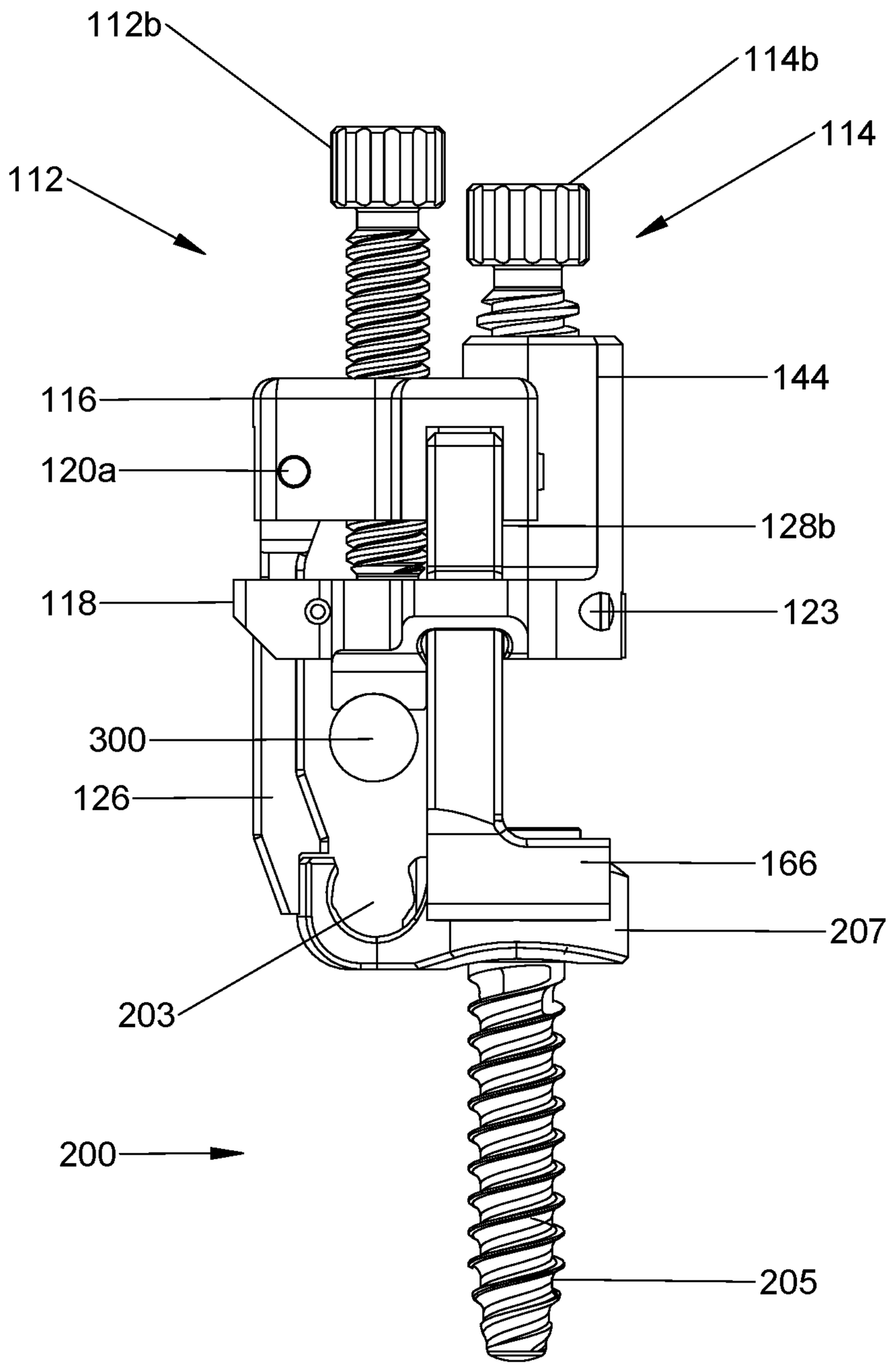
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FIG. 12

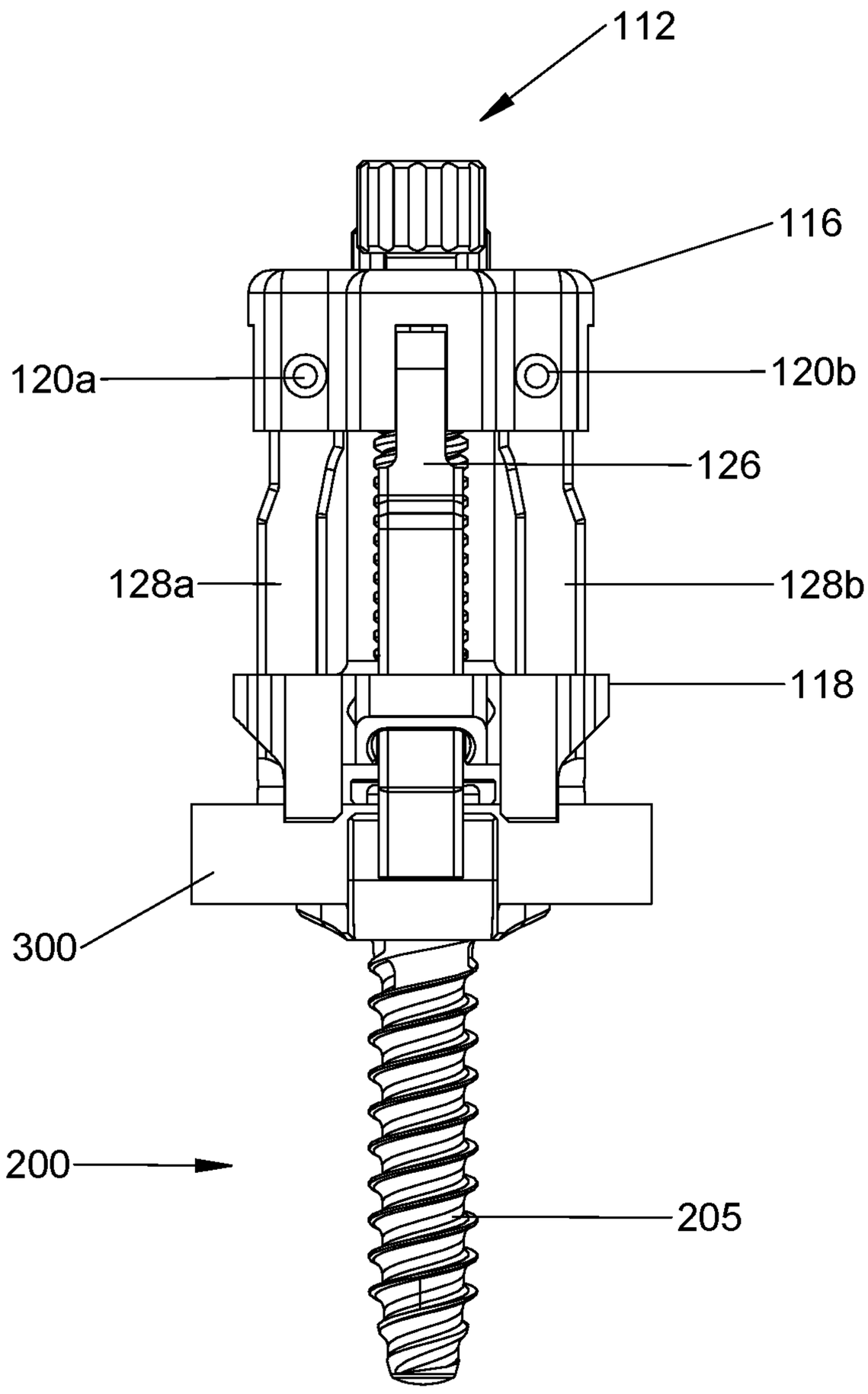

FIG. 13

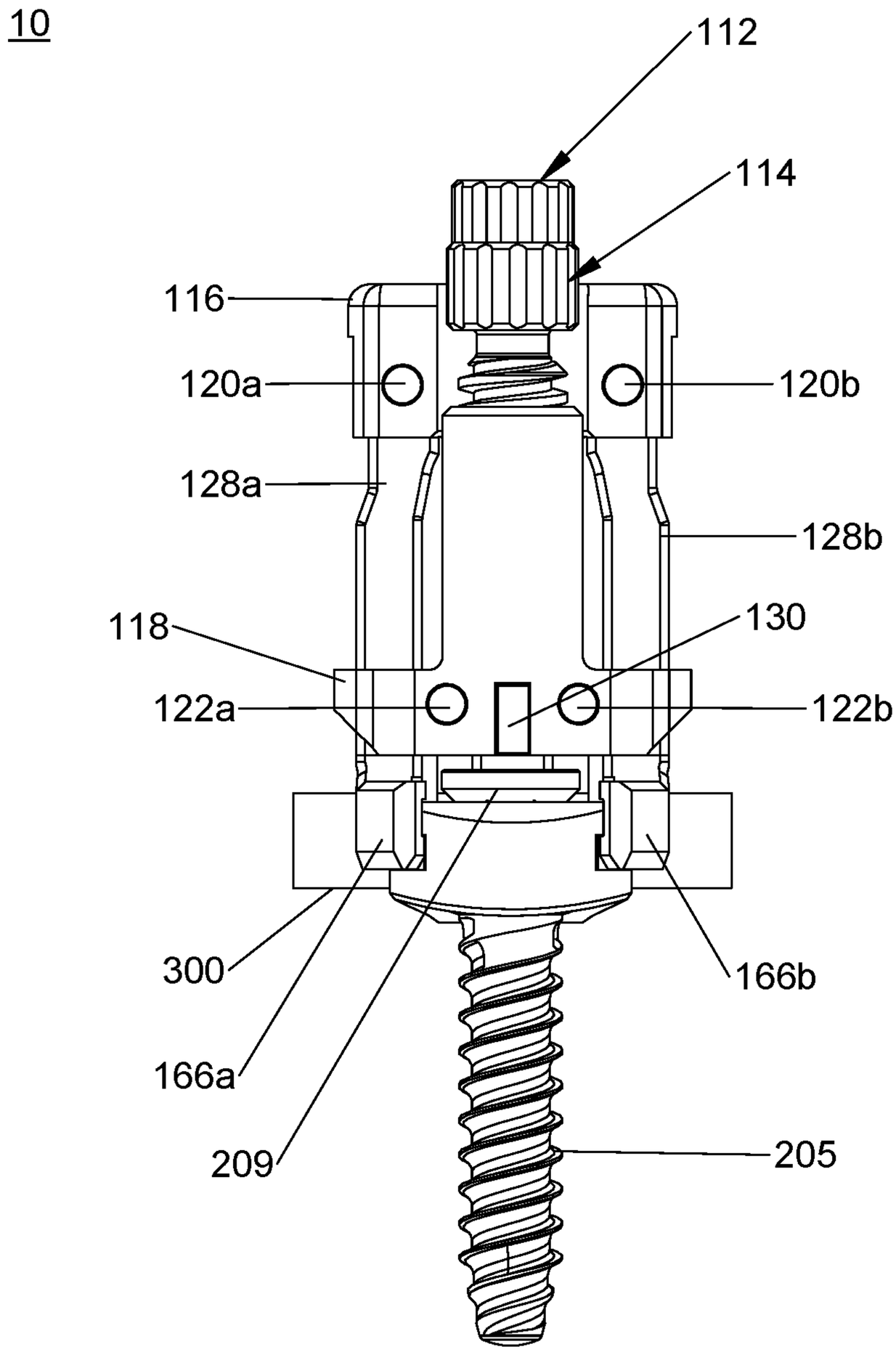
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FIG. 14

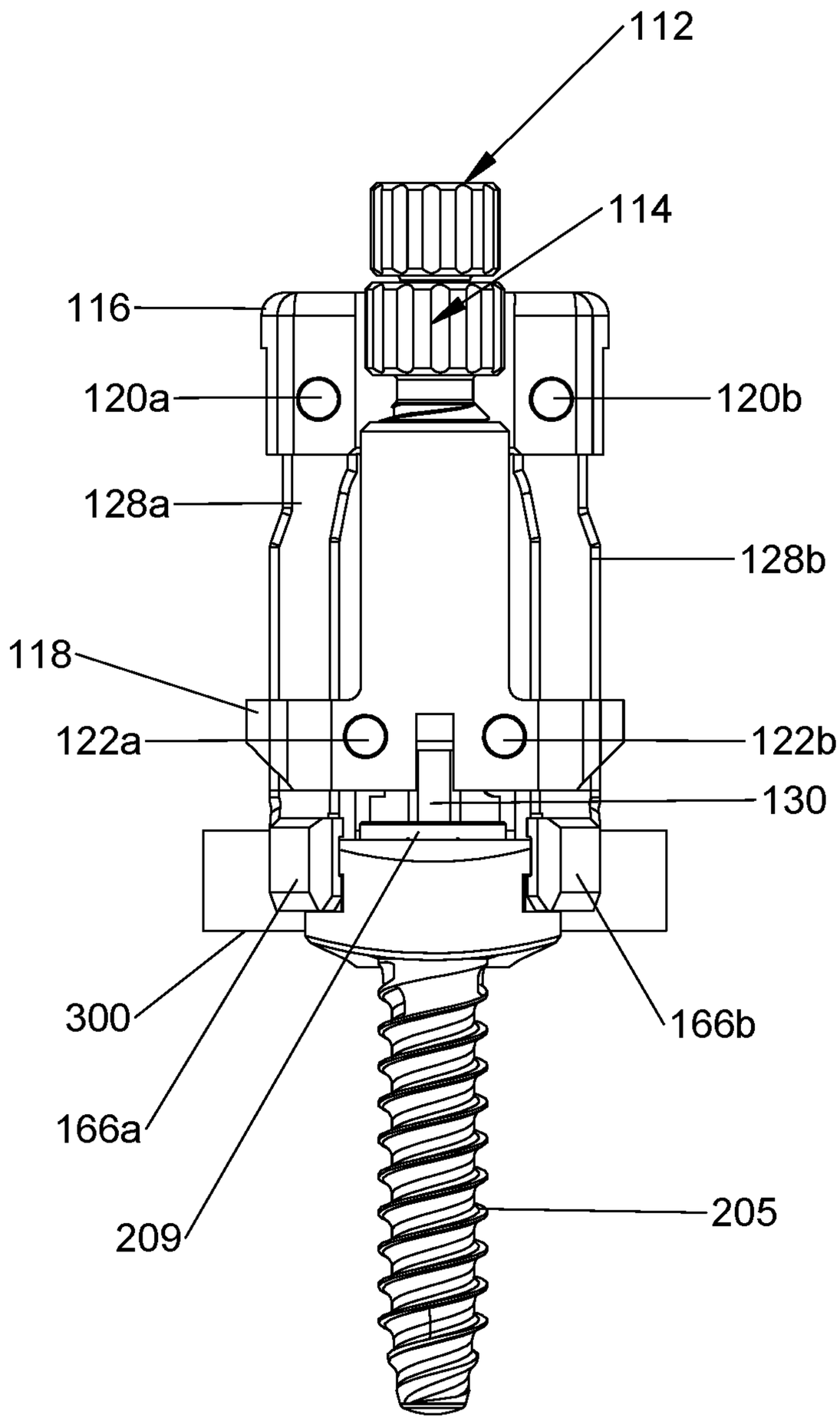
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FIG. 15

ROD REDUCING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 15/873,370, filed on Jan. 17, 2018 which claims the benefit of U.S. Provisional Application Ser. No. 62/447,519, which was filed on Jan. 18, 2017, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates to spinal surgery and, more particularly, to systems, devices, and methods for reducing spinal rods into bone screw housings and/or for manipulation of a spinal column.

BACKGROUND

There are various disorders, diseases and types of injury, which the spinal column may experience in a lifetime. One of the more common solutions to treating these conditions involves a surgical procedure utilizing mechanical hardware. The mechanical hardware used to immobilize the spinal column typically involves a series of bone screws and spinal rods or plates. When the spine surgery is performed, it is common practice to place bone screws into the vertebral bodies and then connect a spinal rod between adjacent vertebral bodies.

The process of properly inserting the spinal rod into the receiving slot of a bone screw and then securing that connecting spinal rod in place often can require that the surgeon use a number of instruments and expend a great deal of time and effort to accomplish the task. When bone screws in several adjacent vertebrae are to be securely connected by a spinal rod, the repeated process of inserting the spinal rod into the heads of the bone screws and then securing the spinal rod in place for each respective bone screw can be difficult, tiresome and time consuming. Further, the alignment of the spinal rod as it connects to each of the sequential bone screws may require adjustment during the procedure and, therefore it is beneficial that a device and method be provided by which the spinal rod can be reduced into the head of each of the sequentially aligned bone screws and, as desired, easily adjusted so as to facilitate the process for the surgeon with minimal effort and loss of time.

For these reasons there remains a need for a device that is capable of securely grasping the head of a bone screw in a controlled, measured manner and reducing a spinal rod into the head of that bone screw in such a way as to permit easy position adjustment as other portions of the spinal rod are reduced into other bone screws.

SUMMARY

In accordance with an embodiment of the present disclosure, there is provided a rod reducer that effectively reduces in a controlled, measured way a spinal rod into position in a head of a bone screw and holds that spinal rod in position while other portions of the spinal rod are positioned and reduced into other bone screws allowing for position adjustment as necessary during the process. The rod reducer includes a housing, an anvil, a locking anvil, an arm assembly, a reducing screw, and a locking screw. The anvil is operatively coupled with the housing, and includes a rod positioning portion configured to engage a spinal rod. The locking anvil is configured to engage a locking plug of a bone screw assembly. The arm assembly includes an arm hingedly coupled to the housing and extending through the anvil, and first and second grasping members configured to engage the bone screw assembly. The first and second grasping members are hingedly coupled to the housing and extend through the anvil. The reducing screw extends through the housing and is rotatably coupled with the anvil. The locking screw extends through the housing and is rotatably coupled with the locking anvil. Rotation of the reducing screw transitions the arm assembly between an open position, in which, distal portions of the arm and the first and second grasping members are radially expanded, and a closed position, in which, the distal portions of the arm and the first and second grasping members are radially contracted.

In an embodiment, the reducing screw may be rotatably coupled with the anvil while inhibiting relative axial displacement therebetween.

In another embodiment, the housing may define a plurality of cutouts dimensioned to receive the arm and the first and second grasping members.

In yet another embodiment, the anvil may include an elongate member defining a threaded bore configured to threadably engage the locking screw.

In still yet another embodiment, the locking screw may be rotatably coupled with the locking anvil while inhibiting relative axial displacement therebetween.

In another embodiment, the first and second grasping members may define first and second guide channels dimensioned to engage the bone screw assembly when the arm assembly is in the closed position.

In yet another embodiment, the rod positioning portion of the anvil may define an arcuate recess configured to engage the spinal rod.

In still yet another embodiment, the reducing screw may threadably engage the housing.

In an embodiment, the anvil may define a cutout configured to slidably receive at least a portion of the locking anvil to facilitate axial displacement of the locking anvil relative to the anvil.

In accordance with another embodiment of the present disclosure, there is provided a system for reducing a spinal rod into a bone screw assembly including a spinal rod, a bone screw assembly, and a rod reducer. The bone screw assembly includes a rod receiving portion configured to receive the spinal rod, and a housing including a locking plug transitionable between a locked state, in which, the spinal rod is securely fixed to the rod receiving portion and an unlocked state, in which, the spinal rod is repositionable with respect to the rod receiving portion. The rod reducer includes a housing, an anvil operatively coupled with the housing, a locking anvil configured to engage the locking plug of the bone screw assembly, an arm assembly, a reducing screw, and a locking screw. The anvil includes a rod positioning portion configured to engage the spinal rod. The arm assembly includes an arm hingedly coupled to the housing and extending through the anvil, and a pair of grasping members configured to engage the bone screw assembly. The pair of grasping members is hingedly coupled to the housing and extends through the anvil. The reducing screw extends through the housing and is rotatably coupled with the anvil. The locking screw extends through the housing and is rotatably coupled with the locking anvil. Rotation of the reducing screw transitions the arm assembly between an open position, in which, distal portions of the arm and the pair of grasping members are radially expanded,

and a closed position, in which, the distal portions of the arm and the pair of grasping members are radially contracted.

In an embodiment, rotation of the locking screw may cause axial displacement of the locking anvil relative to the anvil.

In another embodiment, the arm may be configured to engage the rod receiving portion of the bone screw when the arm assembly is in the closed position.

In yet another embodiment, the locking anvil may be configured to impart axial force to the locking plug of the bone screw assembly to transition the housing of the bone screw assembly between the unlocked state to the locked state.

In accordance with another aspect of the present disclosure, there is provided a method of reducing a spinal rod including transitioning a rod reducer to an open state, in which, distal ends of an arm and grasping members of the rod reducer are radially expanded; mounting the rod reducer over a bone screw assembly; positioning a spinal rod adjacent a rod receiving portion of the bone screw assembly; rotating a reducing screw of the rod reducer to transition an anvil of the rod reducer away from a housing of the rod reducer to a closed state, in which, the distal ends of the arm and the grasping members of the rod reducers are radially contracted to engage the bone screw assembly; reducing the spinal rod into the rod receiving portion; and securing the spinal rod to the rod receiving portion by rotating a locking screw of the rod reducer to advance a locking plug into a bone screw housing of the bone screw assembly.

In an embodiment, rotating the reducing screw of the rod reducer may include engaging the arm of the rod reducer with the rod receiving portion of the bone screw.

In another embodiment, rotating the reducing screw of the rod reducer may include engaging the grasping members with the bone screw housing of the bone screw assembly.

In yet another embodiment, partially inserting the locking plug into the bone screw housing of the bone screw assembly may include making adjustments to the spinal rod.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the disclosure and, together with a general description of the disclosure given above, and the detailed description of the embodiment(s) given below, serve to explain the principles of the disclosure, wherein:

FIG. **1** is a front view of a rod reducer and a bone screw assembly in accordance with an embodiment of the present disclosure;

FIG. **2** is a perspective view of the rod reducer of FIG. **1**;

FIG. **3** is a side view of the rod reducer of FIG. **2**;

FIG. **4** is an exploded perspective view of the rod reducer of FIG. **1** with parts separated;

FIG. **5** is a perspective view of a housing of the rod reducer of FIG. **1**;

FIG. **6** is a perspective view of an anvil of the rod reducer of FIG. **1**;

FIG. **7** is a top view of the rod reducer of FIG. **2**;

FIG. **8** is a cross-sectional view of the rod reducer of FIG. **7** cut along a section line **8-8**;

FIG. **9** is a front view of the rod reducer of FIG. **1** illustrating the reducing device in an open position;

FIG. **10** is a side view of the rod reducer and the bone screw assembly of FIG. **1** illustrating the rod reducer mounted on the bone screw assembly;

FIG. **11** is a front view of the rod reducer and the bone screw assembly of FIG. **1** illustrating the rod reducer mounted on the bone screw assembly;

FIG. **12** is a side view of the rod reducer and the bone screw assembly of FIG. **1** illustrating use with a spinal rod;

FIG. **13** is a front view of the rod reducer and the bone screw assembly of FIG. **12** illustrating reduction of the spinal rod;

FIG. **14** is a rear view of the rod reducer and the bone screw assembly of FIG. **13**; and

FIG. **15** is a rear view of the rod reducer and the bone screw assembly of FIG. **14** illustrating a locking anvil engaging a locking plug of the bone screw assembly.

DETAILED DESCRIPTION

Embodiments of the presently disclosed devices are described in detail with reference to the drawings, in which like reference numerals designate identical or corresponding elements in each of the several views. As used herein, the term "distal" or "leading" refers to that portion of the device that is farther from the user, while the term "proximal" or "trailing" refers to that portion of the device that is closer to the user. In addition, the term "cephalad" is known to indicate a direction toward a patient's head, whereas the term "caudad" indicates a direction toward the patient's feet. Further still, the term "lateral" is understood to indicate a direction toward a side of the body of the patient, i.e., away from the middle of the body of the patient. The term "posterior" indicates a direction toward the patient's back, and the term "anterior" indicates a direction toward the patient's front. As used herein, the term "clinician" refers to a doctor, nurse, or other care provider and may include support personnel. In the following description, well-known functions or constructions are not described in detail to avoid obscuring the present disclosure in unnecessary detail.

With reference to FIGS. **1-3**, a system for reducing a spinal rod is shown and generally designated as **10**. The system **10** for reducing a spinal rod **300** (FIG. **14**) includes a rod reducer **100**, a bone screw assembly **200**, and the spinal rod **300**. The rod reducer **100** is configured to be mounted on the bone screw assembly **200** to reduce the spinal rod **300** into a bone screw housing **207** of the bone screw assembly **200**. The rod reducer **100** includes a housing **116**, an anvil **118** configured to engage the spinal rod **300** to place the spinal rod **300** in the bone screw housing **207**, an arm assembly **120** operatively coupled with the housing **116**, a locking anvil **130** (FIG. **4**) configured to engage a locking plug **209** of the bone screw assembly **200** in order to securely fix the spinal rod **300** with the bone screw assembly **200**, a reducing screw **112** operatively coupled with the anvil **118**, and a locking screw **114** operatively coupled with the locking anvil **130** (FIG. **4**). The housing **116** and the anvil **118** may be unitary structures.

With reference to FIGS. **4** and **5**, the housing **116** includes a body **116***a* defining a bore **140** configured to threadably receive the reducing screw **112** therein, and a recess **138** dimensioned to receive the locking screw **114** therein. The housing **116** includes cutout portions **158***a*, **158***b*, **158***c*. The cutout portion **158***a* defines opposing holes **119***a* dimensioned to receive a pin **120***a* to hingedly secure an arm **126** of the arm assembly **120** (FIG. **1**) to the housing **116**. Similarly, the cutout portions **158***b*, **158***c* define respective holes **119***b*, **119***c* dimensioned to receive respective pins **120***b*, **120***c* to hingedly secure respective grasping members **128***a*, **128***b* of the arm assembly **120** to the housing **116**. The cutout portions **158***b*, **158***c* may oppose each other such that

the grasping members **128***a*, **128***b* may engage diametrically opposed portions of the bone screw housing **207** (FIG. **1**) of the bone screw assembly **200** for secure and balanced engagement with the bone screw assembly **200**. The bore **140** may be centrally defined in the body **116***a*, and the recess **138** may be interposed between the cutout portions **158***b*, **158***c*. In addition, the recess **138** may include an arcuate profile to receive the locking screw **114**.

With particular reference to FIG. **4**, the reducing screw **112** includes a distal portion **112***a* defining an annular groove **154***a* configured to rotatably engage a tongue portion **148***a* (FIG. **6**) of a third hole **140***b* defined in a base portion **118***a* of the anvil **118**, a proximal portion **112***b* defining a cavity **132***a*, and a threaded portion **112***c* extending between the proximal and distal portions **112***a*, **112***b*. The cavity **132***a* includes, e.g., a hex, key feature for non-slip engagement with a driver or other instrument (not shown) to drive the reducing screw **112**. Similarly, the locking screw **114** includes a distal portion **114***a* defining an annular groove **155***a* configured to rotatably engage a tongue portion **149** of the locking anvil **130**, a proximal portion **114***b* defining a cavity **132***b*, and a threaded portion **114***c* extending between the proximal and distal portions **114***a*, **114***b*. The cavity **132***b* includes, e.g., a hex, key feature for non-slip engagement with a driver or other instrument (not shown) to drive the locking screw **112**. It is contemplated that cavities **132***a*, **132***b* may have any suitable configuration such as, e.g., slotted, square, star fitting, or a Phillips head, for engagement with the driver. It is also envisioned that the threaded portions **114***c* of the locking screw **114** may be, e.g., a coarse acme thread, configured to support more load, whereas the threaded portion **112***c* on the reducing screw **112** may be a finer thread.

With reference now to FIGS. **4** and **6**, the anvil **118** includes a base portion **118***a*, an elongate portion **145** extending proximally from the base portion **118***a*, and a pair of rod positioning portions or rod positioning members **146** (only one shown) extending distally from the base portion **118***a*. The base portion **118***a* defines a hole **134** dimensioned to receive the arm **126** therethrough, second holes **136***a*, **136***b* dimensioned to receive the respective grasping members **128***a*, **128***b* therethrough, and a third hole **140***b* dimensioned to receive the reducing screw **112**. In particular, an inner wall **148** of the third hole **140***b* includes a tongue portion **148***a* extending radially inward from the inner wall **148**. The tongue portion **148***a* is configured to engage the annular groove **154***a* of the reducing screw **112** such that the reducing screw **112** is rotatably secured with the anvil **118**, while inhibiting relative axial movement with the anvil **118**. The elongate portion **145** extends proximally from the base portion **118***a*. The elongate portion **145** defines a threaded bore **145***a* configured to threadably engage the locking screw **114**. The rod positioning members **146** extend distally from the base portion **118***a* and are configured to engage the spinal rod **300** (FIG. **14**) to position the spinal rod **300** into the bone screw housing **207** (FIG. **1**) of the bone screw assembly **200**.

The base portion **118***a* further defines a locking pin hole **123** (FIG. **4**) dimensioned to receive a locking pin **122**. The locking pin **122** is configured to limit axial displacement of the locking screw **114**. The base portion **118***a* can further define a cam pin hole **125** that extends across a portion of the hole **134**. The cam pin hole **125** can be configured and dimensioned to receive a cam pin **124** (FIG. **4**). Under such a configuration, when the rod reducer **100** transitions between open (FIG. **9**) and closed positions (FIG. **2**), i.e., radial expansion and contraction of the arm **126** and the grasping members **128***a*, **128***b*, camming portions **160***a*, **160***b* of the arm **126** can slidably engage the cam pin **124**. In the open position (FIG. **9**), each of the arm **126** and the grasping members **128***a*, **128***b* defines an acute angle with respect to a central longitudinal axis of the housing **116**. In the closed position (FIG. **2**), each of the arm **126** and the grasping members **128***a*, **128***b* is substantially parallel with the central longitudinal axis of the housing **116**.

With reference to FIGS. **4** and **8**, the arm assembly **120** includes the arm **126** and first and second grasping members **128***a*, **128***b* configured to engage the bone screw housing **207** (FIG. **14**). The arm **126** is dimensioned to extend through the first hole **134** (FIG. **6**) of the anvil **118**. The arm **126** includes a distal portion **126***a* and a proximal portion **126***b*. The proximal portion **126***a* is hingedly coupled to the cutout portion **158***a* (FIG. **5**) of the housing **116** by the pin **120***a*. The proximal portion **126***b* includes the camming portion **160***a*, and the distal portion **126***a* includes a camming portion **160***b* having a longitudinally tapered surface. Such a configuration facilitates transition of the arm **126** between the radially contracted (closed) and radially expanded (open) positions. Each of the elongate grasping members **128***a*, **128***b* may also include respective camming portions **161***a*, **161***b* in order to facilitate radial contraction and expansion thereof. Each of the grasping members **128***a*, **128***b* includes respective lobes **166***a*, **166***b*. Each lobe **166***a*, **166***b* defines a guide channel **168***a*, **168***b* (only **168***b* shown) dimensioned to engage the bone screw housing **207** of the bone screw assembly **200**.

With continued reference to FIGS. **4** and **8**, the locking anvil **130** defines a cavity **131** dimensioned to receive the distal portion **114***a* of the locking screw **114**. In particular, the locking anvil **130** includes a tongue portion **149** received in the annular groove **155***a* of the locking screw **114** to rotatably secure the locking anvil **130** with the locking screw **114**, while inhibiting relative axial movement therebetween. Under such a configuration, the locking anvil **130** may be moved relative to the anvil **118**. The locking anvil **130** includes a guide **130***c* dimensioned to be slidably received in a cutout **118***c* defined in the anvil **118** in order to guide axial movement of the locking anvil **130**. Under such a configuration, the clinician may rotate the locking screw **114** in order to move the locking anvil **130** toward and away from the anvil **118**.

With reference now to FIG. **10**, the bone screw assembly **200** includes the bone screw housing **207** configured to receive a locking plug **209** (FIG. **14**), a threaded shaft **205** extending distally from the bone screw housing **207**, and a rod receiving portion **203** disposed adjacent the bone screw housing **207**. With brief reference to FIG. **14**, when the locking anvil **130** engages the locking plug **209**, through rotation of the locking screw **114**, the locking plug **209** is advanced into the bone screw housing **207**, which, in turn, causes the rod receiving portion **203** to grasp the spinal rod **300** disposed therein, thereby securing the spinal rod **300** with the bone screw assembly **200**. The locking plug **209** is movable amongst an open or unlocked state that allows insertion and/or removal of the spinal rod **300**, a partially locked state that allows rotation and longitudinal movement of the spinal rod **300** relative to the bone screw assembly **200**, and a locked state that securely fixes a position of the spinal rod **300** with respect to the bone screw assembly **200**. This arrangement allows the clinician to reduce the spinal rod **300** into the rod receiving member **203** while still being able to perform additional adjustments to the spinal rod **300** during the procedure.

In use, initially, the bone screw assembly **200** is mounted to a vertebra (e.g., screwed in to the vertebra) of a spine (not shown) such that the rod reducer **100** can be mounted on the bone screw assembly **200**. With reference to FIG. **9**, the rod reducer **100** is initially placed in an open position, in which, the arm **126** and the grasping members **128***a*, **128***b* are radially expanded by placing the reducing screw **112** in, e.g., a proximal-most position, in which the anvil **118** is positioned adjacent the housing **116**. Under such a configuration, the distal portion **126***a* of the arm **126** and the lobes **166***a*, **166***b* of the grasping members **128***a*, **128***b* are spaced apart to receive the bone screw housing **207**. In order to mount the rod reducer **100** to the bone screw assembly **200**, the rod reducer **100** is positioned over the proximal portion of the bone screw assembly **200** (FIG. **1**).

The arm **126** and the grasping members **128***a*, **128***b* are hingedly coupled to the housing **116** such that the arm **126** and the grasping members **128***a*, **128***b* can rotate radially outward about the respective pins **120***a*, **120***b*, **120***c* (FIG. **4**) and transition between the radially contracted (closed) (FIG. **2**) and expanded (open) (FIG. **9**) positions. As the anvil **118** moves away from the housing **116**, the cam pin **124** (FIG. **8**) slides against the camming portion **160***a*, **160***b* (FIG. **4**) of the arm **126**. Similarly, as the anvil **118** moves away from the housing **116**, the camming portions **161***a*, **161***b* (FIG. **4**) of each of the grasping members **128***a*, **128***b* slide against the anvil **118**. In this manner, the clinician can rotate the reducing screw **112** in order to move the anvil **118** distally, which, in turn, causes the arm **126** and the grasping members **128***a*, **128***b* to transition to the closed position. At this time, the lobes **166***a*, **166***b* of the grasping members **128***a*, **128***b* are secured with the bone screw housing **207**, and the distal portion **126***a* of the arm **126** engages the rod receiving member **207** of the bone screw assembly **200**.

At this time, the spinal rod **300** (FIG. **14**) may be placed adjacent the rod receiving member **203** (FIG. **12**) of the bone screw assembly **200**. Alternatively, the spinal rod **300** may be placed adjacent the rod receiving member **203** prior to mounting the rod reducer **100** to the bone screw assembly **200**. The clinician can further rotate the reducing screw **112** to move the rod positioning member **146** of the anvil **118** to reduce the spinal rod **300** into the rod receiving recess **203** of the bone screw assembly **200**.

With reference to FIGS. **12** and **14**, the spinal rod **300** may be secured in the rod receiving recess **203** of the bone screw assembly **200** by utilizing the locking plug **209**. In particular, the locking screw **114** may be rotated causing the locking anvil **130** to move relative to the anvil **118** toward the locking plug **209**. With additional reference to FIG. **15**, additional displacement of the locking anvil **130** advances the locking plug **209** into the bone screw housing **207**, which, in turn, causes the spinal rod **300** to be securely fixed in the rod receiving recess **203**. In this manner, the locking anvil **130** contacts the locking plug **209** and causes an interference fit which grips the spinal rod **300**. It is also envisioned that the locking plug **209** may be partially locked or advanced into the bone screw housing **207** in order to make further adjustments to the spinal rod **300** as described hereinabove.

Persons skilled in the art will understand that the structures and methods specifically described herein and shown in the accompanying figures are non-limiting exemplary embodiments, and that the description, disclosure, and figures should be construed merely as exemplary of particular embodiments. It is to be understood, therefore, that the present disclosure is not limited to the precise embodiments described, and that various other changes and modifications may be effected by one skilled in the art without departing from the scope or spirit of the disclosure.

Additionally, the elements and features shown or described in connection with certain embodiments may be combined with the elements and features of certain other embodiments without departing from the scope of the present disclosure, and that such modifications and variations are also included within the scope of the present disclosure. Accordingly, the subject matter of the present disclosure is not limited by what has been particularly shown and described.

The invention claimed is:

1. A method of reducing a spinal rod comprising:

transitioning a rod reducer to an open state, in which, distal ends of a first arm and grasping members of the rod reducer are radially expanded;

positioning the rod reducer over a bone screw assembly;

positioning a spinal rod adjacent a rod receiving portion of the bone screw assembly;

rotating a reducing screw of the rod reducer to transition an anvil of the rod reducer away from a housing of the rod reducer to a closed state, in which, the distal ends of the first arm and the grasping members of the rod reducers are radially contracted to engage the bone screw assembly;

reducing the spinal rod into the rod receiving portion; and

rotating a locking screw of the rod reducer to move a locking anvil to advance a locking plug into a bone screw housing of the bone screw assembly to secure the spinal rod to the rod receiving portion, the locking screw and the locking anvil being rotatably coupled to one another.

2. The method of claim **1**, wherein rotating the reducing screw of the rod reducer includes engaging the first arm of the rod reducer with the rod receiving portion of the bone screw assembly.

3. The method of claim **2**, wherein rotating the reducing screw of the rod reducer includes engaging the grasping members with the bone screw housing of the bone screw assembly.

4. The method of claim **2**, wherein the reducing screw is rotatably coupled with the anvil.

5. The method of claim **1**, further comprising partially rotating the locking screw to partially advance the locking plug into the bone screw housing of the bone screw assembly and making adjustments to the spinal rod.

6. The method of claim **1**, wherein rotation of the locking screw causes axial displacement of the locking anvil relative to the anvil.

7. The method of claim **1**, wherein the locking anvil imparts an axial force to the locking plug to transition the housing of the bone screw assembly to a locked state.

8. The method of claim **1**, wherein the locking anvil advances within a cutout of the anvil.

9. The method of claim **1**, wherein when the locking screw is rotated, the locking screw threadably engages a threaded bore of the anvil.

10. A method of reducing a spinal rod comprising:

positioning a rod reducer over a bone screw assembly;

positioning a spinal rod adjacent a rod receiving portion of the bone screw assembly;

transitioning an anvil of the rod reducer to transition a first arm and grasping members of the rod reducer from a radially expanded position to a closed position, in which, the first arm and the grasping members of the rod reducers are radially contracted to engage the bone screw assembly;

reducing the spinal rod into the rod receiving portion; and

rotating a locking screw of the rod reducer to move a locking anvil to advance a locking plug into a bone screw housing of the bone screw assembly to secure the spinal rod to the rod receiving portion, the locking screw and the locking anvil being rotatably coupled to one another.

11. The method of claim **10**, wherein the step of transitioning the anvil includes rotating a reducing screw of the rod reducer.

12. The method of claim **10**, further comprising partially advancing the locking plug into the bone screw housing of the bone screw assembly and making adjustments to the spinal rod.

13. The method of claim **10**, wherein the reducing step includes rotating a reducing screw of the rod reducer.

14. The method of claim **13**, wherein the locking screw and the locking anvil are rotatably coupled together.

15. The method of claim **10**, wherein rotating the reducing screw of the rod reducer includes engaging the first arm of the rod reducer with the rod receiving portion of the bone screw.

16. The method of claim **15**, wherein rotating the reducing screw of the rod reducer includes engaging the grasping members with the bone screw housing of the bone screw assembly.

17. The method of claim **10**, wherein the locking anvil advances within a cutout of the anvil.

18. A method of reducing a spinal rod comprising:

transitioning a rod reducer to an open state, in which, distal ends of a first arm and grasping members of the rod reducer are radially expanded;

positioning the rod reducer over a bone screw assembly;

positioning a spinal rod adjacent a rod receiving portion of the bone screw assembly;

rotating a reducing screw of the rod reducer to transition an anvil of the rod reducer away from a housing of the rod reducer to a closed state, in which, the distal ends of the first arm and the grasping members of the rod reducers are radially contracted, the grasping members engage the bone screw housing of the bone screw assembly, and the first arm of the rod reducer engages the rod receiving portion of the bone screw assembly;

reducing the spinal rod into the rod receiving portion; and

rotating a locking screw of the rod reducer to axially move a locking anvil relative to the anvil to advance a locking plug into a bone screw housing of the bone screw assembly to transition the housing of the bone screw assembly to a locked state to secure the spinal rod to the rod receiving portion, the locking screw and the locking anvil being rotatably coupled to one another.

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